HALEAKALĀ CRATER: ITS RESOURCES AND MANAGEMENT PROBLEMS

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INTRODUCTION

The Crater District of Haleakala National Park (HALE) is the most accessible tropical alpine ecosystem in Hawai'i. When compared with the other alpine areas in the State, i.e., Mauna Loa and Mauna Kea, it is also the most typical and least disturbed example of a tropical alpine ecosystem.

The Crater District extends from 4000 feet in the Kaupō Gap to the summit at 10,024 feet. The climate fluctuates between greater seasonal extremes than in most other areas of the State, and above approximately 8000 feet the daily fluctuations are extreme, providing what Hedberg (1951) called "summer every day, winter every night." The area is quite small (12 X 4 km, 7545 ha) yet supports a rain forest on its eastern boundary and desert along the western crater rim. This desert is due more to the daily temperature variations and the high permeability of the substrate than to a lack of moisture.

The Crater District has fascinated biologists in the past but most of their work has been directed at describing species or writing general descriptive accounts of the area. However, a few papers, e.g., Yocum (1967), have dealt with resource management problems. The majority of the resources are now well-documented particularly with the conclusion of the Haleakalā Crater District Resources Basic Inventory (RBI). By comparing the results of this work with previous studies it is possible to describe the scope of the biological resources as well as to identify the resource management problems, the specific threats to the integrity of these resources and to suggest appropriate remedial action.

BIOLOGICAL RESOURCES

Haleakalā Crater has all the plant communities typically found in tropical alpine areas although the species composition is understandably different. One of these communities, the rosette life-form dominated by the Haleakalā silversword (*Argyroxiphium macrocephalum* Gray), has been so severely disrupted by feral herbivores and man that its extent and dominance have been

seriously degraded (Whiteaker 1980). This one shortcoming notwithstanding, Haleakalā Crater provides a very important scientific resource for the study of plants and plant communities in tropical alpine environments. Haleakalā also has the only extensive high elevation native grassland and the highest bog in the State.

The Crater is an island on an island and just as the isolation of the Hawaiian Islands has resulted in extensive speciation so has the isolation of the Crater. For example, over 20% of the native insects found in the Crater are endemic to the Crater and its environs (Beardsley 1980). Comparatively high levels of precinctiveness (local endemism) are also found in other groups, e.g., 6% of the lichens, 5% of the mosses, 8% of the native flowering plants.

The insect fauna deserves special mention here because of the high number of flightless species (e.g., Hodegia apatella Walsingham, Pseudospectra lobipennis Perkins). Perkins (1899-1913) believes that flightlessness in the Hawaiian Islands is due to the lack of any selective pressure to maintain flighted forms. Once evolved, flightless insects remain very localized and are generally more subject to extirpation if the environmental conditions change than their flighted counterparts. It is not clear if this is the correct interpretation for flightless forms atop Haleakalā because there may have been a selective advantage to not flying in an area where winds can reach speeds in excess of 130 kph.

The Crater is the principal breeding ground of the endangered 'Ua'u or Hawaiian Dark-rumped Petrel (Pterodroma phaeopygia sandwichensis). It is also a very important habitat in the restoration program for the endangered Nēnē or Hawaiian goose (Branta sandvicensis). The habitat of most of the other native birds in the area has been severely disrupted so that only scattered populations of these species remain in the area.

PROBLEMS

All of the resource management problems in Haleakalā Crater are the result of the activities of post-contact man. The aboriginal Hawaiians had an impact in the area but it was minor and transitory compared with today's almost continuous activity. The problems include feral mammals (herbivores, carnivores, omnivores) and exotic birds, plants, and insects, as well as the direct impact of man.

Feral herbivores.--The grazing, browsing, rooting, and trampling of feral herbivores (e.g., cattle (Bos taurus L.), goats (Capra hircus L.), horses (Equus caballus L.), pigs (Sus scrofa L.), and the potential threat from the axis deer (Axis axis (Erxleben)) have had and will continue to have a devastating

impact on individual species, plant communities, and the total Haleakalā ecosystem. At least 12 taxa of plants have been extirpated from the area; of these, 7 were local endemics. However, the loss of species is only part of the problem. Selective grazing has depleted some of the dominant species of the ecosystem, e.g., māmane (Sophora chrysophylla (Salisb.) Seem.). Significant modifications in the ecological processes are the inevitable consequence of such changes.

The loss of vegetation through grazing or browsing opens up the community. This impact is particularly disruptive in high elevation ecosystems where growth and recovery are slow. The invasion of exotic grasses, principally Yorkshire fog (Holcus lanatus L.), frequently prevents the reestablishment of the native shrubs with consequent changes in the structure of the community. Since much of the Crater is in the inversion layer where fog interception is an important source of water, reduction of the vegetation results in a decrease in water capture. The effects of such a decrease are not known but it is suspected that the groundwater in the area is depleted because several high elevation springs have dried up over the last 50 years.

The loss of vegetation and drying out of the environment coupled with trampling and other soil disturbances have also resulted in an increase in soil erosion. Some areas, e.g., Kuiki, have lost their original ash-derived topsoil. The area will never recover to form a grassland because the necessary deep soil cannot be replaced. Thus an important area of Nēnē habitat has been lost. Much the same is true of the cliffs surrounding the Crater and some areas of Kaupō Gap.

The carnivores.--Feral cats (Felis catus L.) and dogs (Canis familiaris L.) are present in the area. Their densities are low and their impact is not known. If the opportunity presented itself there is little doubt that they would kill any bird they were able to catch.

The omnivores.--These organisms present several different problems most of which are the result of their impact on native species which evolved in the absence of that type of selection pressure.

The mongoose (Herpestes auropunctatus (Hodgson)) is thought to be the most serious threat to the ground and subterranean nesting birds. The scope of this problem is not known but both Banko (pers. comm.) and Simons (pers. comm.) think that much of the lack of breeding success in the Nēnē and 'Ua'u can be attributed to egg, chick, and nesting adult predation by this species. The density of these mammals is extremely low. They are rarely seen but their impact is severe. Because of their low densities the chances of their finding a nest are low but once found, there is every indication that the nest will be destroyed.

Rats (Rattus spp.) have long been suspected of predating on the eggs and young of the endemic honeycreepers. They are now known to have severely depleted native endemic plants by eating seeds, e.g., the Haleakalā sandalwood (Santalum haleakalae Hbd.), or girdling the bark of trees, e.g., koa (Acacia koa Gray).

Exotic birds.--Very little is known about the impact of exotic birds on native species. However, Conant and Stemmermann (1979) suspect that the exotic granivorous birds may be depleting the food resources of the Nēnē. All these exotic species are host to exotic parasites and thus may be subjecting the Nēnē to debilitating diseases, etc. Jacobi (pers. comm.) has suggested recently that chukar (Alectoris chukar) and pheasant (Phasianus spp.) may be eating the emergent māmane seedlings.

Exotic plants.--Two species are a very real concern. Gorse (Ulex europaeus L.) is currently confined to two small patches close to the Park headquarters building. Its continued existence after five years of control and eradication illustrates its tenacity and the enormous management problems it would create if it became established elsewhere in the Park. The other species is kikuyugrass (Pennisetum clandestinum Hochst. ex Chiov.), an important range grass in the State. It is established in many areas of the Crater but is a problem only in the lower east segment of Kaupō Gap where it is choking the dryland forest.

Several introduced grasses--e.g., orchardgrass (Dactylis glomerata L.), Yorkshire fog, Kentucky bluegrass (Poa pratensis L.), etc.--will probably remain troublesome as long as pigs root up the ground creating the disturbance on which these grasses depend for establishment.

Exotic insects.--Two species are of particular concern here, the Argentine ant (Iridomyrmex humile (Mayr)) and the ground-nesting yellowjacket (Vespula pennsylvanica (Saussure)). The former will predate on almost any insect in its environment. It is very probable that the flightless species will be extirpated if the Argentine ant reaches their habitat. The yellowjacket is a potential predator of native moth and butterfly larvae as well as being a serious threat to humans sensitive to their sting.

Man.--The continued direct impact of man in the area is another serious threat. Experiencing the wilderness has to be done responsibly with a full understanding of the fragility of the area and the problems that man can cause. By not sticking to trails, taking short cuts, or creating new trails, not only is the wilderness disrupted but exotics such as the evening primrose (Oenothera laciniata Hill) are introduced to new areas. These new trails are not planned with soil conservation in mind and they frequently create local erosion problems. Thus, the area of unimpacted habitat for wildlife is further fragmented with a potentially devastating impact on sensitive species.

DISCUSSION

The mission of the National Park Service (NPS) is essentially conservation for current and future visitor enjoyment. According to the policies of the Service, conservation is not to be interpreted as preservation but as conservation of the ecological processes native to the area such that the ecosystem may be maintained in the mold that existed prior to the influences of western civilization. The Endangered Species Law will require some modification of this general policy in specific instances in that to preserve an endangered species may require outright preservation of an ecotype, seral stage, etc. Knowing the resource management problems how do we establish priorities? How much weight should we give to legal, economic, and biological concerns?

The Endangered Species Law presents some major resource management problems for the National Park Service. For example, two species in Haleakalā Crater, the 'Ua'u and the Nēnē, are provided with the full protection of this law. As a consequence of this legal protection, resource management activity is directed toward these species. In a time of contracting fiscal support the tendency will be to take care of immediate problems only. Other problems will be ignored or passed over no matter how significant because of the lack of fiscal support. Yet, an exotic predator which could extirpate 10 to 20 species in a matter of years, e.g., the Argentine ant and its potential impact on the endemic flightless insects of the Crater, will be ignored because two species which are officially recognized as endangered have the full protection of the law and, thereby, the immediate attention of managers. Is it proper that we should allow 10 to 20 locally endemic species to be driven into extinction to save two other more widely distributed species just because some have political support whereas others do not? From a biological point of view this approach is unacceptable. If the area is to be conserved the first priority should be those elements which are unique to that environment.

Exotic influences should be managed where they interfere with the native ecological processes. All trophic levels must be considered but it would not be inappropriate to emphasize the primary producers (plants) because all other organisms are dependent on them, either directly or indirectly, for nourishment. Organisms, or groups of organisms, that interfere with native ecological processes must be controlled or eliminated if possible. Most biologists are agreed that the feral herbivores, particularly goats, are having the greatest negative impact on the Haleakalā crater ecosystem. Their impact is extensive reaching beyond the direct consequences of their herbivory. Boundary fencing, coupled with an aggressive eradication program of the herbivores, is the only practical solution to this problem. Eradication is the ultimate goal but initially we will probably have to accept decimation of the populations.

The question that immediately arises is what priorities should be established, and what is the rationale for setting those priorities? It would seem eminently logical that those management problems which have the greatest impact on the largest number of species should receive the highest priority. That being the case, the list for Haleakalā Crater would appear to be as follows:

1. Eradication of the feral herbivores.
2. Control of the Argentine ant.
3. Eradication of kikuyugrass from the dryland forest.
4. Restoration of the central crater ecosystem.
5. Conservation of the 'Ua'u.
6. Restoration of the Nēnē.

On purely political grounds the list would probably be:

1. Restoration of the Nēnē.
2. Conservation of the 'Ua'u.
3. Restoration of the central crater ecosystem.
4. Control of the Argentine ant.
5. Eradication of kikuyugrass from the dryland forest.
6. Eradication of the feral herbivores.

The almost reversed listing of this short list of resource management problems dependent on the criteria used for ranking illustrates the difficulty facing the managers. Were funds generally available the answer would be relatively easy. However, the current dual approach of supporting research to better define the issues while simultaneously experimenting with various management strategies and techniques is only a political response to the dilemma. Until a greater commitment is made at the national level to respond to the needs of Haleakala National Park no significant progress will be made. Some volunteer activities are taking place but they are small and transitory.

On a rather different level the issues of human use and enjoyment of this area need further attention. The direct and indirect impact of visitors to the Crater must be critically evaluated and controlled as soon as possible. Allowing access to all areas so that people can enjoy the wilderness experience may be a satisfactory short-term policy but without any substantive idea on the carrying capacity of this environment the policy is fraught with potential disaster. People entering the area must be aware of the necessity for responsible behavior because recovery from abuse in these alpine ecosystems is a long, slow process. Visitors must confine their activities to the trails, and cutting new trails and short cuts should be expressly prohibited and enforced.

In conclusion, we now know the biological resources in Haleakalā Crater. We also have some very clear priorities for the management of those resources. However, it is clear that within this area there are some organisms, e.g., Nēnē, 'Ua'u, flightless insects, the silversword, the geraniums, whose autecology we need to understand in much greater detail before

proceeding with any but the most general resource management strategies. At the same time, we must continue to monitor all the resources in the area. It is imperative that new immigrants be detected early so that management can be implemented while it still has a chance of succeeding. It is time that the managers be allowed to respond to these problems by adequate fiscal support.

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